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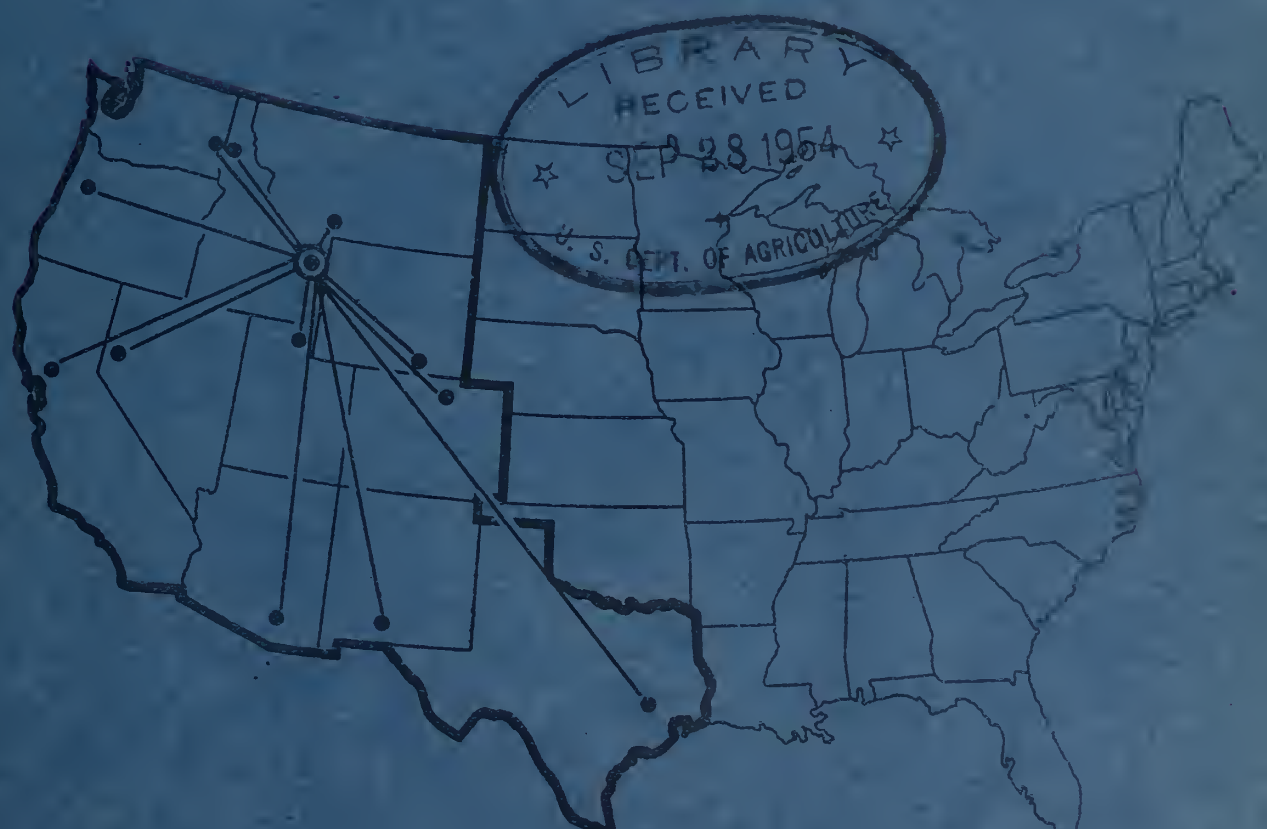
UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ANIMAL INDUSTRY
AND COOPERATING STATES

EIGHTH ANNUAL REPORT OF THE WESTERN SHEEP BREEDING LABORATORY AND THE U.S. SHEEP EXPERIMENT STATION

DUBOIS, IDAHO
JUNE 30, 1945



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ANNUAL REPORT
Western Sheep Breeding Laboratory
and
U. S. Sheep Experiment Station
June 30, 1945

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HONOR ROLL

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Corp. Lowell O. Wilson	19136415, 36th Photo Recon. Squadron A. P. O. #74, c/o P. M. San Francisco, California

DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS
OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING
WITH THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	P. S. Burgess, University of Arizona, Tucson.
CALIFORNIA:	C. B. Hutchison, University of California, Berkeley.
COLORADO:	H. J. Henney, Colorado State Agricultural College, Fort Collins.
IDAHO:	E. J. Iddings, University of Idaho, Moscow.
MONTANA:	Clyde McKee, Montana State College, Bozeman.
NEVADA:	S. B. Doten, University of Nevada, Reno.
NEW MEXICO:	A. S. Curry, Acting Director, New Mexico State College of Agriculture, State College.
OREGON:	W. A. Schoenfeld, Oregon State College, Corvallis.
TEXAS:	C. H. McDowell, Acting Director, Agricultural and Mechanical College of Texas, College Station.
UTAH:	R. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	E. C. Johnson, Washington State College, Pullman.
WYOMING:	J. A. Hill, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	Ernest B. Stanley, Head, Department of Animal Husbandry. College of Agriculture, University of Arizona, Tucson.
CALIFORNIA:	James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.
COLORADO:	A. Lamar Esplin, Department of Animal Husbandry, Colorado State College of Agriculture and Mechanic Arts, Fort Collins.
IDAHO:	C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.
MONTANA:	Richard T. Clark, Head, Department of Animal Husbandry, Montana State College, Bozeman.
NEVADA:	Charles E. Fleming, Department of Range Management, College of Agriculture, University of Nevada, Reno.
NEW MEXICO:	Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College.
OREGON:	Ray G. Johnson, Head, Department of Animal Husbandry Oregon State Agricultural College, Corvallis.
TEXAS:	Bruce L. Warwick, Department of Animal Industry, Texas Agricultural Experiment Station, College Station.
UTAH:	R. H. Walker, Director, Utah State Agricultural Experiment Station, Logan.
WASHINGTON:	M. E. Ensminger, Head, Department of Animal Husbandry, State College of Washington, Pullman.
WYOMING:	Fred S. Hultz, Head, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

ROSTER OF PERSONNEL

WESTERN SHEEP BREEDING LABORATORY AND U. S. SHEEP EXPERIMENT STATION
Dubois, Idaho, as of June 30, 1945

Name	Rating	Date entered on duty	General Duties
Nordby, Julius E.,	Principal Animal Husbandman, P-6	Mar. 1, 1938	Director
Terrill, Dr. Clair E.,	Animal Husbandman P-4	July 3, 1936	Geneticist, Physiologist
Stoehr, John A.,	Animal Husbandman P-4	August 28, 1928	Operations
*Pohle, Elroy M.,	Animal Fiber Technologist, P-3	May 2, 1938	Wool Technologist
Hazel, Dr. Lanoy N.,	Animal Husbandman P-3	Sept. 1, 1942	Statistician and Geneticist
*Sidwell, George M.,	Animal Husbandman P-1	July 1, 1941	Assistant, Physiology and Genetics
*Emik, Dr. L. Otis.,	Animal Husbandman P-1	July 7, 1941	Assistant, Physiology and Genetics
*Keller, Henry R.,	Animal Husbandman P-2	Oct. 16, 1941	Assistant, Wool laboratory
Sidlinger, Henry M.,	Administrative Asst., CAF-7	June 1, 1945	Administrative Assistant
*Schaefer, Chester F.,	Clerk, CAF-3	June 22, 1936	Clerk
**Harrison, Raymond H.,	Clerk, CAF-3	Oct. 25, 1937	Clerk
#Taylor, Lois A.,	Clerk, CAF-3	April 17, 1944	Secretary
*Wilson, Lowell O.,	Scientific Aid SP-4	July 1, 1943	Assistant, Wool laboratory
***Hensley, Gladys L.,	Clerk-Typist CAF-2	April 2, 1945	Clerk-Typist
***Lawson, Pauline C.,	Clerk-Typist CAF-2	May 28, 1945	Clerk-Typist
***McDonald, Judith L.,	Clerk-Typist CAF-2	June 1, 1945	Clerk-Typist
***Smith, Ruth K.,	Clerk-Typist CAF-2	June 1, 1945	Clerk-Typist
Taylor, Jessie S.,	Clerk-Typist CAF-2	May 29, 1945	Clerk-Typist
Jeffery, Lee C.,	Foreman of Farm Laborers, CPC-6	June 7, 1924	General maintenance pumps, equipment
Rasmussen, Henry, Jr.	Farm Laborer CPC-5	July 1, 1926	Farm Laborer
Hohman, Max E.,	Farm Laborer CPC-4	April 1, 1935	Shepherd

ROSTER OF PERSONNEL (Con'd)

Landacre, Harold E.,	Farm Laborer CPC-4	April	6, 1939	Truck driver, general maintenance
Goldman, James R.,	Farm Laborer CPC-4	May	1, 1939	Shepherd
***Schoener, Clifford C.,	Farm Laborer CPC-4	August	3, 1944	Shepherd
Howard, John H.,	Farm Laborer CPC-4	Oct.	2, 1944	Shepherd
Barger, Frank S.,	Farm Laborer CPC-4	March	27, 1945	Shepherd
Walker, Raymond,	Farm Laborer CPC-4	April	6, 1944	Shepherd & Camp Tender
Phillips, Walter H.,	Farm Laborer CPC-4	March	16, 1935	Truck Driver
Powell, Fred A.,	Farm Laborer CPC-4	May	11, 1935	Teamster
***Wharton, Hyrum P.,	Unskilled Laborer	March	16, 1945	Unskilled Laborer
Nantz, Dorinda R.,	Unskilled Laborer	June	16, 1941	Janitress & Cook

On leave without pay.

* On Military leave.

** Transferred to War Department, with re-employment benefits.

*** Employees on temporary War Service Appointments.

F O R E W O R D

The basic design of the improvement program at this Laboratory does not afford a great deal of opportunity for major short-time advances in measurable progress because sheep reproduce rather slowly. The second generation is now in production. Moreover, the flocks involved are of relatively high productive capacity, under which condition improvement with any system of breeding would move somewhat slowly.

Changes in production occur from year to year. These are in a measure environmental, and may occur in such a manner that they obscure to some degree genetic changes from one generation to another. This would be particularly true if genetic progress were relatively slight.

Data have now been analyzed which afford a workable accurate estimate of the heritability of various useful characteristics. In the interpretation and application of the heritability of a character, there is still ample room for caution in drawing conclusions, and, for that reason, it is doubtful if the reader will discover many cases in this report where gains have been credited to genetic change unless there is fairly clear evidence available.

S U M M A R Y

The basic nature of the improvement program at this Laboratory has not offered a great deal of opportunity for major short-cut measures in measurable progress because clone reproduction rather [illegible]. The second generation is now in production. Moreover, the clonal families are of relatively high productive capacity, hence rapid [illegible] improvement with any system of breeding would have proceeded slowly.

Changes in production occur from year to year. These are in a measure environmental, and may occur in such a manner that they obscure to some degree genetic changes from one generation to another. This would be particularly true if genetic progress were relatively slight.

Data have not been analyzed which afford a reliable accurate estimate of the heritability of various useful characteristics. In the interpretation and application of the heritability [illegible], there is [illegible] for changes in density [illegible]. For this reason, it is doubtful if the reader will discover many cases in this report where gains have been credited to genetic change unless there is fairly clear evidence available.

OBJECTIVE

The main objective of this laboratory is to improve sheep for lamb and wool production under range conditions. In the pursuit of this objective basic breeding methods are employed; heritability analyses are made of the various utility factors, and the selection of breeding animals is based upon production as that is measured under range environment. Emphasis is placed primarily on the quantity and quality of lambs produced; the length, quality and quantity of clean scoured wool, and upon the adaptability and longevity of the sheep.

RESEARCH LINE PROJECTS

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

   (a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with emphasis on selection for all characters of economic importance.
   (b) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.

2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep, such as defective jaws, abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stock.

3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including

   (a) Sexual maturity of Rambouillet ram lambs.
   (b) Quality of semen in relation to fertility, and
   (c) Factors affecting fertility of ewes.

4. Studies in the physiology of wool production of Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in relation to the total uniformity of the fleece.

5. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory.

OBJECTIVE

The main objective of this laboratory is to improve sheep for lamb and wool production under range conditions. In the pursuit of this objective basic breeding methods are employed, particularly analyses of the various utility factors; and the selection of breeding animals is based upon production so that the resultant meets range environments. Emphasis is placed primarily on the quantity and quality of lambs produced; the length, quality and quantity of clean scoured wool; and upon the adaptability and longevity of the sheep.

RESEARCH LINE PROJECTS

1. Development of systems of breeding for founding strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

   (a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with moderate, or selection for all characters of economic importance.
   (b) The development of inbred lines with special reference to very important characters that are of economic importance in range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.

2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep, such as defective jaws, abnormalities in the growth of wool, hairiness in fleece of wool and excessive neck folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stocks.

3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including

   (a) Sexual maturity of Rambouillet ram lambs,
   (b) Quality of semen in relation to fertility, and
   (c) Factors affecting fertility of ewes.

4. Studies in the physiology of wool production in Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in addition to the total uniformity of the fleece.

5. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory.

A CHALLENGE TO RESEARCH IN SHEEP IMPROVEMENT

As research workers interested in the fundamental improvment of sheep for western ranges, we are basically concerned with the matter of reorganizing the germ plasm in sheep to the end that more useful wool and meat can be produced more efficiently. Such an accomplishment should normally mean a safer economy for the sheep ranchman. The state and federal experiment stations share in the progress that has been made. Informed ranchmen are quite willing to concede that research has and still is making contributions, but they are rather inactive in the application of these advances (See page 18, No. 6 Vol. 35, June 1945, the National Wool Grower for discussions on the Influence of Research in Stabilizing the Changing Sheep Production Economy).

In industry, when an improvement in efficiency arises through research effort, it is very quickly activated into the production line. Fundamental research, applied research and economic research are closely coordinated and function together for progress in industrial research. The basic economy of industry, which is very sensitive to competitive enterprize, rewards constructive change that is brought about through research, because it is the very life of industry. In agriculture, basic economy can possibly not vary materially from the concept of the same fundamental principles of production and trade that characterize industry. Research gives rise to new forms, new methods, and new creations. These new forms, new methods, and new creations are the 'catalysts' of change. If they are not activated into their respective sphere of potential influence in industry and in agriculture, further research tends to be stymied. These new processes and new creations, as they are activated into our economic structure,--and have accordingly an influence on our social structure, encourage uniformily the need for research in all commodities and for the activation and applications of research accomplishment into all lines of industry and agriculture. In those phases of industry and agriculture in which research does not leaven the adjustment away from orthodoxy, production and marketing may lack the all-over coordinated progress that makes for economic stability and agreement in change.

Research in wool production has pointed the way--a practical way--for improving quality and increasing quantity. This march of progress has been little short of sensational during the last 25 years in the West. But total research results in production and marketing have not been fully syncronized to our existing economy.

The marketing of domestic wool by the producer is very primitive. In general, our domestic wool marketing system is a severe indictment against our interest in an intelligent understanding of fundamental economics. Since it is so important to test the wheat, barley or oats we sell to determine values, why is it not far more important to determine the actual value of wool that is worth fifty

times as much per pound as wheat, oats or barley? Yet, year after year, with inadequate courage to interfere with a deeply intrenched system of guessing shrinkage values, the producers of wool in the West generously contribute millions of dollars as gifts to a very economically unpractical system. How much have we bettered ourselves if we spend 12 to 16 years of effort in raising the annual production of wool per sheep from 10 to 11 pounds if we allow someone to buy the total wool on an estimated shrink of 60% when it may be actually only 55% shrink wool. The one pound increase of grease wool, or ½ lb. of scoured wool gain, which we have spent 12-16 years to produce is the difference between a 55 and 60 percent shrink in a 10 lb. fleece. This gift of fifty cents per fleece may actually constitute all of the net profit or even more than the total net in the production of that fleece. And, very obviously, we cannot recover even production costs on that part of the fleece which we give away--such a gift must come from the net profit of the business,-- when there is such a net.

The attitude among the sheepmen is rather general that discrepancies in shrinkage estimates obtain for the most part in better than average wools, and are most pronounced in the wools with the lightest shrink. If this is right, then it would tend to discourage flock wool improvement for clean wool. Full advantage of improvement through research cannot be realized under our present system of marketing wool Any improvement that is made in quantity production is recognized in our present system of marketing. But that is not so true in quality improvement. It is a "bulk in the grease" market and not a "quality clean wool" market.

But, in spite of a faulty marketing system that appears to favor total weight in wool without full record for clean content, research must continue to dignify its true functions in coordinating basic values all along the production and marketing lines.

The cause for distress in the matter of shrinkage errors should not be reason for incriminating wool appraisers. Wool appraising is an art. Its function is to appraise wool on the basis of its value in fabric production, and not to guess at the amount of residue in a pound of grease wool, which can now be determined with workable accuracy by methods of science. The appraiser's inability in becoming efficient in guessing at the amount of shrink in grease wool should not be a cause for criticism on the art of appraising the value of wool fiber. The trade is asking him to do something he cannot possibly do. May the application of research achievement come to his rescue!

In general, research workers in agricultural pursuits are somewhat disturbed because the discoveries that have practical application in production are very often not activated into production lines by the producers concerned,--a situation which exists much less frequently in industry. There are, of course, some reasons for this. Industrial units have, as a rule, their own research staffs that are responsible for guiding changes in production and also in marketing. And, obviously,

them 5¢ each per pound at which, much to farmers' ire, year after year, with inadequate courage to interfere with a deeply entrenched system of guessing shrinkage values, the producers of wool in the West perennially contribute millions of dollars as tribute to a very economically unpractical system. How much have we bettered ourselves if we spend 15 to 20 years of effort in raising the normal production of wool per sheep from 10 to 11 pounds if we allow someone to buy the total wool on an estimated shrink of 60% when it may be actually only 50% shrinkage. The one pound increase of grease wool, or ½ lb. of scoured wool gain, which we have spent 15-20 years to produce is the difference between a 57 and 60 percent shrink on a 10 lb. fleece. This gift of thirty cents per fleece may actually constitute all of the net profit or even more than the total net in the production of that fleece. And, very obviously, we cannot recover even production costs on that part of the fleece which we give away--such a gift must come from the net profit of the business,-- when there is such a net.

The attitude among the sheepmen is rather general that discrepancies in shrinkage estimates obtain for the most part on better than average wools, and are most pronounced in the wools with the lightest shrink. If this is right, then it would tend to discourage flock improvement for clean wool. Full advantage of improvement through research cannot be realized under our present system of marketing wool. Any improvement that is made in quantity production is penalized in our present system of marketing. The same is true in quality improvement. It is a "bulk in the grease" market and not a "quality clean wool" market.

But, in spite of a faulty marketing system that appears to favor total weight in wool without full regard for clean content, research must continue to dignify its true function in coordinating basic values all along the production and marketing lines.

The cause for distress in the matter of shrinkage errors should not be reason for berating wool appraisers. Wool appraising is an art. Its function is to appraise wool on the basis of its value to fabric production, and not to guess at the amount of residue in a pound of grease wool, which can only be determined with reasonable accuracy by methods of science. The appraiser's inability to become efficient in guessing at the amount of shrink in grease wool should not be a cause for criticism on the art of appraising the value of wool fiber. The trade is asking him to do something he cannot possibly do, lacking the application of research achievements made to his needs.

In general, research workers in agricultural pursuits are somewhat disturbed because the discoveries made by experimental application or generation are very often not conveyed into disseminating lines by the producers concerned,-- a situation which exists much more frequently in industry. There are, of course, some reasons for this. Commercial units have, as a rule, their own research staffs that are responsible for guiding changes in production and also in marketing. But, ultimately,

any gains indicated by research are promptly in evidence along the production lines. Commercial agricultural ventures, of which there are many who finance their own research staffs, likewise promptly adopt research contributions though it may be done at great cost.

Sheep production is a business of individual enterprise. And though the sheep industry is organized to serve the producer in a number of ways, it is doubtful if even our over-all organization recognizes fully how the industry may profit basically by giving some of its time to a fuller appreciation of research accomplishments and their activation into production and marketing. Their function has been largely concerned with problems that develop as a result of political adjustments which may get out of line with reference to comparative gains enjoyed by industry through legislation.

Since production, and in general marketing, is largely a matter of individual enterprise, we, as research workers, should probably examine the effectiveness of the methods we must employ in getting into production the gains we claim through research. Are we also attempting to sell to the sheep industry our accomplishments through individual enterprise. We publish the result of our efforts, but we rarely do anything more about them. In some cases, perhaps, the agency for extending the application of these discoveries into the field may not be fully informed, or it may not be sympathetic with the idea of applying to one area a change that should be approached with a consolidated front, such as, for instance, the needed reform in shrinkage determinations. Area differences are not, in general, adequate cause for lack of consolidated effort.

Dare we offer a suggested solution for fear it may be too idealistic. The motive involved, however, is one of profound altruism, despite the fact that it is also concerned with a deep desire for effective "selling" of research accomplishments. Any suggestion is probably justified, though it may appear idealistic, on the basis that idealism may quicken our enquiry for a practical solution.

As individuals, charged with the collaboration in and administration of an organization whose function it is to improve sheep, we each know something about the problems involved. Together we know vastly more than any one individual. Let us also assume that together we could do vastly more than any individual can do alone. If we are willing to admit that this latter premise is correct then it follows that ways and means to attack general problems collectively should be sought.

Suppose then we go far afield and attempt to visualize a consolidated selling and activating service for research in the western states. As a working basis we might suggest a research advisory council comprising a workable number of men selected from the collaborating and laboratory personnel, whose function it would be to serve as a liaison group between the National Wool Growers Association

and cause indicated by natural law presently in evidence along the production lines. Commercial agricultural ventures, of which there are many who finance their own research staffs, likewise promptly adopt research contributions though it may be done at great cost.

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and the over-all organization of this laboratory in matters affecting the sheep industry in the West. Herein, probably lies the opportunity to dignify research to the end that it could exert a very potent influence in a setting where it has not been influential heretofore. Such a plan would not interfere in any way with any method now in use for disseminating information among sheep producers. It would be in addition to them.

Challenges to research workers come also from breeders. At the annual meeting of the Columbia Sheep Breeders of America, May 25, 26, 1945 it was proposed to elect a committee composed of five technically trained experiment station men to be known as the Research Advisory Council of the Columbia Sheep Breeders Association of America. The primary function of this council will be to advise with the association on matters pertaining to the continuous improvement of the Columbia breed through the search for contributing genes that may not now obtain in the breed. These, when found, would be introduced into the breed on approval of the association.

This action on the part of the Columbia Sheep Breeders Association of America provides those who are interested in basic sheep improvement with some material for long range thinking. It obviously provides that the registration books of the association will remain open for entry of outside breeding upon recommendation of the Research Advisory Council and the discretion of the Association. This action carries with it some important implications. It implies that the Columbia breed, in its present stage of development, may not be possessed of all the available genes that would contribute to the usefulness of the breed, or that, if they are present, it would require a longer period of time to effect the optimum grouping of these genes within the breed than it would require to find them in outside sources and introduce them systematically into the breed. This implication appears to be well founded. In any such effort the Research Council will, in general, know the source of these new genes and also the pattern that is utilized in their introductions. This action also tests our very concept of the term "breed", and thereby challenges research in its pursuit of improvement even as that might apply to existing breeds. It most assuredly forces our attention to the very basic concept that no breed has a monopoly on all the desirable genes, and infers thereby that a systematic approach affecting a revitalized gene complex, though it may be in part exotic, may yield closer agreement between the production efficiency of our breeds and economic necessity.

The agricultural extension service in sheep husbandry in one of our range states, in cooperation with the ram sale committee and the State Wool Growers Association, has undertaken a courageous step in attempting to get an improved picture of wool production in rams that are offered for sale in the state ram sale. Ways and means have been devised to measure wool growth on rams that are submitted for entry, and the result of the study is posted at the ram sale so buyers will be informed. Herein may lie a hopeful opportunity to enlighten the industry to the end that sheepmen will be more able to properly evaluate the usefulness of rams for effecting improvement than might be possible without this information.

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This action on the part of the Columbia Sheep Breeders Association of America provides those who are interested in basic sheep improvement with some material for long range thinking. It obviously provides that the registration books of the association will remain open for entry of outside breeding upon recommendation of the Research Advisory Council and the discretion of the association. This action carries with it some important implications. It implies that the Columbia breed, in its present stage of development, may not be possessed of all the available genes that would contribute to the usefulness of the breed, or that, if they are present, it would require a longer period of time to effect the optimum grouping of these genes within the breed than it would require to find them in outside sources and introduce them systematically into the breed. This implication appears to be well founded. In any such effort the Research Council will, of course, know the source of these new genes and also the pattern that is utilized in their introductions. This action also marks our very concept of the term "breed", and thereby challenges a position in the pursuit of improvement, such as that might apply to existing breeds. It more pointedly forces our attention to the very basic concept that no breed has a monopoly on all the desirable genes, and it also emphasizes that a systematic approach affording a revitalized gene complex, though it may be in part artificial, may yield closer agreement between the production efficiency of our breeds and economic necessity.

The agricultural extension service in sheep husbandry in one of our range states, in cooperation with the experiment station and the State Wool Growers Association, has undertaken a courageous step in attempting to get an improved measure of wool production in rams that are offered for sale in the state ram sale. These sale rams have been confined to measure wool growth on rams that are consigned for the sale, and the results of the study is posted at the ram sale so buyers will be informed. Herein may lie a powerful opportunity to enlighten the industry to the end that the sheepmen will be more able to properly evaluate the usefulness of rams for effecting improvement than might be possible without this information.

Since lamb production is relatively more important to the producer than wool production, it follows that research, both fundamental and applied, must seek basic values in the improvement of sheep for this quality. Though it is, no doubt, more difficult to measure because it is more sensitive to environmental changes, it is probable that new and more workable techniques for correctly appraising advances in lamb production must be found. Research must continue to challenge empirical methods, because rarely can any of these lay claim to immortality.

It is common practice now in commercial production to seek maximum heterosis in the flocks, or at least in the lambs that are produced. There may be no fault to find with this practice. In general, this is uncontrolled heterosis, except as the producer uses rams of another breed. However, if this practice is correct for the commercial producer, what must be the method employed by the ram breeder in order that the commercial producer can continue his method? If maximum uncontrolled heterosis is the practice in stud flocks, then the commercial producer has lost control of his plan within the breed. Maximum uncontrolled heterosis usually can be effected by the use of rams that are the product of controlled heterosis or by the use of inbred sires, of which there are not enough for the purpose, that carry a high potential for transmitting production genes. It appears to be the function of research to lead the way in making possible maximum heterosis for the commercial producer. Systematic inbreeding of stud flocks is probably one of the most effective means of accomplishing this end, a means which is now being tested experimentally at this Laboratory.

PUBLICATIONS

The following papers have been published or mimeographed since the beginning of the Western Sheep Breeding Laboratory in 1937. The complete list is included this year in order to show corrections and additions to previous lists. A number of contributions have been made to livestock journals and the general press that are not included in this series. They are for the most part adaptations of the regular series, prepared for the lay reader. Publications of range studies by the Forest Service and publications of abstracts are presented in separate lists.

1. Measurement of Reproductive Capacity as an Aid in Selection of Rams of High Fertility (A Preliminary Report). C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1937, pp. 311-316.

2. Artificial Insemination of Ewes. C. E. Terrill and E. M. Gildow, National Wool Grower 27(12):35, Dec., 1937.

3. Another Experiment on Long Range Paternity in Sheep. C. E. Terrill and E. M. Gildow, Jour. of Heredity 29(2):77-78, Feb.,1938.

4. Artificial Insemination of Ewes with Transported Semen. E. M. Gildow and C. E. Terrill, Jour. of Amer. Vet. Med. Assoc. N. S. 46(3):157-159, Sept., 1938.

5. Reproductive Capacity of Rambouillet Ram Lambs as Indicated by Semen Tests. C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 308-310.

6. A preliminary Study of the Relation Between Fleece Characteristics of Weanling and Yearling Range Sheep. W. V. Lambert, J. I. Hardy and R. G. Schott, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 298-303.

7. Reproduction in Range Sheep. C. E. Terrill and John A. Stoehr, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 369-375.

8. Selection of Range Rambouillet Ewes, C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 333-340.

9. Comparison of the Accuracy of Two Methods of Estimating Fineness of Wool Fibers. Ralph W. Phillips, R. G. Schott, J. I. Hardy and H. W. Wolf, Jour. of Agr. Res. 60(5):343-350, Mar. 1, 1940.

10. A summary of Three Year's Work in the Transportation of Ram Semen for Artificial Insemination. Ralph W. Phillips, R. C. Schott, E. M. Gildow and C. E. Terrill, to be published in the Proceedings of the Second National Meeting of Veterinary Surgeons of Italy, 1940.

11. The Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station. Julius E. Nordby, Extension Animal Husbandman, Sept., 1940.

12. Genetics and Range Sheep Improvement. Julius E. Nordby, Scientific Monthly 51:310-320, Oct., 1940.

13. Some Factors Affecting the Progeny Testing of Rams. Ralph W. Phillips, R. G. Schott, W. V. Lambert and G. W. Brier, U. S. D. A. Cir. 580, 17 pp., Oct., 1940.

14. The Application of a Rapid Comparator Method for Determining Fineness and Variability in Wool. Elroy M. Pohle, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 161-168.

15. Comparison of Ram Semen Collection Obtained by Three Different Methods for Artificial Insemination. Clair E. Terrill, Proc. Amer. Soc. of An. Prod., 1940, pp. 201-207.

16. Growth in Corriedale and Rambouillet Sheep under Range Conditions. Ralph W. Phillips, John A. Stoehr and G. W. Brier, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 173-181.

17. Sheep Improvement for Range Production. Julius E. Nordby, Idaho Forester 23, 1941, Forestry School, University of Idaho.

18. A Rapid Method for Expressing Medullation in Wool. Elroy M. Pohle, A. H. D. No. 41, May 1941, 6 pp. (Processed).

19. Columbia Sheep and Their Place in Range Sheep Production. Damon A. Spencer and John A. Stoehr, A.H.D. No. 42, Oct. 1941, 2 pp. (Processed).

20. Targhee Sheep and Their Place in Range Sheep Production. Damon A. Spencer and John A. Stoehr, A.H.D. No. 43, Oct., 1941, 2 pp. (Processed)

21. Face Covering in Range Sheep. Clair E. Terrill. A. H. D. No. 49, Nov., 1941, 9 pp. (Processed).

22. Wool Yield Determination in which Small Samples are Compared with Whole Fleeces. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer, and Glenn W. Brier, A.H.D. No. 50, Jan., 1942, 6 pp. (Processed).

23. Wool Yields in the Small Side-Sample as Related to Individual Whole-Fleece Yields in Form Breed-Groups of Sheep. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Jour. of An. Sci. 1(2):137-144, May, 1942.

24. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(3):221-228, Aug., 1942.

25. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep, Elroy M. Pohle, Jour. of An. Sci. 1(3):229-235, Aug., 1942.

26. Staple Length in Relation to Wool Production. Elroy M. Pohle and Henry R. Keller, Jour. of An. Sci. 2(1):33-41, Feb., 1943.

27. Improving Rambouillet Sheep for Western Ranges. Julius E. Nordby, National Wool Grower 33(3):12-17, Mar., 1943.

28. Staple Length and Its Influence on Shrinkage and Fleece Values. Elroy M. Pohle and Henry R. Keller, National Wool Grower 33(6): 22-24, June, 1943.

29. Stabilizing Wool and Body Type in White Faced Crossbred Sheep for Western Range Production. Julius E. Nordby, National Wool Grower 33(7):15-17, (8):16-18, July and August, 1943.

30. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, U. S. D. A. Cir. 704, 14 pp., Aug., 1944.

31. Wool Fineness in Eight Sampling Regions on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott, Jour. of An. Sci. 2(3): 197-208, Aug., 1943.

32. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces. Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 2(3):181-187, Aug., 1943.

33. Fiber Density and Some Methods of its Measurement in the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 2(3):188-196, Aug., 1943.

34. Estimation of Clean-Fleece Weight from Grease-Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle, L. Otis Emik, and Lanoy N. Hazel, Jour. of Agr. Res. 70(1):1-10, Jan. 1, 1945.

35. Clean-Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 3(2):159-165, May, 1944.

36. Shrinkage and Value by Grades for 1943 Range Wool. Elroy M. Pohle and Henry R. Keller. National Wool Grower 34(6):22-23, June, 1944. (Published in other Wool Growers Magazines)

37. Some Factors Affecting the Blood Phosphorus Level of Range Ewes. W. M. Beeson, Clair E. Terrill and D. W. Bolin, Jour. of An. Sci. 3(2):175-182, May, 1944.

38. The Accuracy of Measurements and Weights of Sheep. Ralph W. Phillips and John A. Stoehr, Jour. of An. Sci. 4(3):311-316, Aug., 1945.

39. Monthly Changes in Fineness, Variability and Medullation in Hairy Lambs. Elroy M. Pohle, H. R. Keller and L. N. Hazel, Jour. of An. Sci. 4(1):37-46, Feb., 1945.

40. More Profit in Open Face Ewes. Clair E. Terrill, Mont. Wool Grower 18(1):13,47, Jan., 1944. (Published in other Wool Growers Magazines)

41. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yields. E. M. Pohle, L. N. Hazel and H. R. Keller, Jour. of An. Sci. 4(2):104-112, May, 1945.

42. Wool Off-Sorts, Percentage, Shrink, Value. Elroy M. Pohle and Henry R. Keller, Montana Wool Grower 18(6):7, June, 1944. (Published in other Wool Growers Magazines)

43. Effectiveness of Selection on Progeny Performance as a Supplement to Earlier Culling in Livestock. G. E. Dickerson and L. N. Hazel, Jour. of Agr. Res. 69(12):459-476, Dec. 15, 1944.

44. Looking Forward, The Stabilizing Influence of Research in a Changing Sheep Production Economy. Julius E. Nordby, National Wool Grower 35(6):18-19, 35-36, June, 1945.

45. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. J. E. Nordby, C. E. Terrill, L. N. Hazel and J. A. Stoehr, Anat. Rec. 92(3), July, 1945.

46. Effects of Some Environmental Factors on Weanling Traits of Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill, to appear in the Journal of Animal Science.

47. Heritability of Weaning Weight and Staple Length in Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill, to appear in the Journal of Animal Science.

48. Heritability of Type and Condition in Range Rambouillet Lambs as Evaluated by Scoring, L. N. Hazel and Clair E. Terrill, submitted to the Journal of Animal Science.

ABSTRACTS

The following abstracts have been published since the beginning of the Western Sheep Breeding Laboratory in 1937. These abstracts are in general of work that has been or will be published and listed in the regular series of publications.

1. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep. Elroy M. Pohle, Jour. of An. Sci. 1(1):60, Feb.,1942.

2. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(1):60-61, Feb., 1942.

3. Fineness of Fiber in Eight Sampling Areas on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott, Jour. of An. Sci. 1(4): 356, Nov., 1942.

4. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces. Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 1(4):356,357, Nov., 1942.

5. Estimation of Clean Fleece Weight from Unscoured Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle and L. Otis Emik, Jour. of An. Sci. 1(4):357, Nov., 1942.

6. A study of the Fiber Density of the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 1(4): 357-358, Nov., 1942.

7. Heritability of Yearling Fleece and Body Traits of Range Rambouillet Ewes. Clair E. Terrill and Lanoy N. Hazel, Jour. of An. Sci. 2(4): 358-359, Nov., 1943.

8. The Effect of Some Factors on the Blood Phosphorus Level of Range Ewes. W. M. Beesen, Clair E. Terrill and D. W. Bolin, Jour. of An. Sci. 2(4):369, Nov., 1943.

9. Clean Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 2(4):370, Nov., 1943.

10. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, Jour. of An. Sci. 2(4):371, Nov., 1943.

11. Effects of Some Environmental Factors on the Weanling Traits of Range Sheep. L. N. Hazel and Clair E. Terrill, Jour. of An. Sci. 3(4):432, Nov., 1944.

12. The Gestation Period of Range Sheep. Clair E. Terrill, Jour. of An. Sci. 3(4):434-435, Nov., 1944.

13. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yield. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 3(4):452, Nov., 1944.

14. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. Julius E. Nordby, Clair E. Terrill, Lanoy N. Hazel and John A. Stoehr, Anat. Rec. 91(4):30, April, 1945.

PUBLICATIONS ON GRAZING PROBLEMS

The Director of the Intermountain Forest and Range Experiment Station, Ogden, Utah has provided the following list of publications by that Station dealing with the problems of range management. Some of the data involved in these publications is the result of cooperative range studies by the Intermountain Forest and Range Experiment Station and the U. S. Sheep Experiment Station. It was thought that the Collaborators of this Laboratory would be pleased to have this list of publications dealing with important problems in range management.

1. The Influence of Climate and Grazing on Spring-fall Sheep Range in Southern Idaho. USDA Tech. Bull. 600, 1938. Geo. W. Craddock and C. L. Forsling.

2. Sampling Error in Range Surveys of Sagebrush-grass Vegetation. Jour. Forestry 39(1): 52-54. 1941. Joseph F. Pechanec.

3. Range Problems of the Sagebrush-grass Type. The Utah Juniper, 12:4-7, 1941. Joseph F. Pechanec.

4. Sagebrush-grass Range Sampling Studies: Variability of Native Vegetation and Sampling Error. Jour. Amer. Soc. Agron. v. 33, No. 12, pp. 1057-1071. 1941. Joseph F. Pechanec.

5. Application of Analysis of Covariance to the Range Research Data. Station Technical Note No. 1 1941. Joseph F. Pechanec.

6. Identification of Grasses on the Upper Snake River Plains by Vegetative Characters. Ecology, 17: 479-90. 1936. Joseph F. Pechanec.

7. An Extension of Range for Blue Grama. Ecology 23: 369. 1942. A. C. Hull, Jr., and Joseph F. Pechanec.

8. A Comparison of Some Methods Used in Determining Percentage Utilization of Grasses. Jour. Agr. Res. 54: 753-65, 1937. Joseph F. Pechanec and G. D. Pickford.

9. A Weight Estimate Method for the Determination of Range or Pasture Production. Jour. Amer. Soc. Agron. 29(11). 1937. Joseph F. Pechanec and G. D. Pickford.

10. Effects of the 1934 Drought on Native Vegetation on the Upper Snake River Plains, Idaho. Ecology 18(4). 1937. Joseph F. Pechanec, G. D. Pickford, and George Stewart.

11. Sagebrush-grass Range Sampling studies: Size and Structure of Sampling Unit. Joseph F. Pechanec and George Stewart. Jour. Amer. Soc. Agron. 32(9). 1940

12. Program of Field Days June 9 and 10, 1938, Held at U. S. Sheep Station. Joseph F. Pechanec and George Stewart. (Mimeo.)

13. The Influence of Continued Heavy Grazing and of Promiscuous Burning on Spring-fall Ranges in Utah. Ecology 13(2). 1932. G. D. Pickford.

14. Grazing Management Needed after Accidental Burns. Research Paper No. 7. Joseph F. Pechanec. April 1944. (Mimeo.)

15. Sagebrush Burning--Good and Bad. U.S.D.A. Farmers' Bulletin 1948. Joseph F. Pechanec and George Stewart. 1944.

16. Improving Sagebrush Ranges by Planned Burning. National Wool Grower, v. 34(6): 13-15, Part I; v. 34(7): 13-15, Part II. Joseph F. Pechanec and George Stewart. 1944.

17. Indicators of Downward Trend in Sagebrush-perennial Grass Ranges Grazed by Sheep in the Spring and Fall. Research Paper No. 12. Joseph F. Pechanec. April 1945. (Mimeo.)

SUMMARY OF RAMBOUILLET -- SPECIAL RESEARCH BREEDING
1944-45 Breeding Season

Pen no.	Ram no.	No. ewes	Face cov. score	Type score	Yearling body weight (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbr. coef. of dams (%)	Age of ewes at lambing (years)
18	619RW	28	4.82	2.14	82.20	8.24	5.93		3.82
19	1261RW	26	4.71	2.24	85.73	8.52	6.02	16.27	4.65
20	1198RW	28	4.67	2.15	86.57	8.37	6.20		3.96
21	1123RW	26	4.51	2.21	84.56	8.59	6.83	7.62	3.73
22	4587W	32	4.47	2.30	89.31	9.30	6.46	11.13	3.56
23	1272RW	26	4.53	2.23	84.92	8.31	5.92		5.27
24	1263RW	29	4.77	2.28	86.72	8.83	6.36	14.26	4.38
25	2885W	28	4.65	2.13	88.57	8.68	6.28	3.04	4.25
26	5589W	28	4.73	2.20	93.61	10.13	6.15	3.13	5.36
27	1230RW	26	4.53	2.19	90.46	8.99	6.02	11.64	4.50
28	3566W	29	4.57	2.17	92.52	9.44	5.79	4.00	5.03
29	466WP	33	4.73	2.05	93.33	9.26	6.52	2.45	3.30
30	5631	32	4.82	2.21	83.47	8.71	6.23	6.97	4.03
31	N.M.911	32	4.68	2.30	84.22	7.84	6.15	5.70	3.81
32	1222RW	33	4.78	2.14	86.55	8.99	6.40	9.86	3.73
34	1244RW	29	4.55	2.18	87.28	8.42	6.28	11.38	4.28
35	4728W	31	4.29	2.25	94.26	8.42	5.83	4.64	4.68
36	4252W	28	4.79	2.15	90.50	8.50	5.96	2.34	3.64
37	3773R	33	4.56	2.04	87.97	9.02	6.48	7.86	4.21
39	3356W	32	4.76	2.28	87.25	8.98	6.30	3.54	4.31
40	5528W	28	3.59	2.20	92.57	8.36	5.98	4.80	3.86
42	5368W	27	4.73	1.97	92.19	8.40	5.92	.29	3.70
43	5666W	30	4.87	2.18	88.60	8.24	6.13	2.50	3.80
44	5223W	33	4.45	2.17	87.81	8.90	6.00	5.06	4.00
45	438WP	28	4.69	1.98	89.39	8.75	6.49	.13	3.14
46	5915W	32	4.72	2.00	91.47	8.61	6.22	3.52	3.22
47	4521W	35	4.44	2.09	89.20	9.22	7.25	3.34	3.71
49	5546W	32	4.31	2.10	97.09	9.07	5.93	1.66	3.93
50	4664W	31	4.43	2.43	90.52	8.93	6.47	4.62	3.65
51	4185W	34	4.42	2.09	91.91	9.02	6.30	.24	4.03
53	4905W	32	4.58	2.07	88.50	8.88	6.48	0	3.84
54	4677W	31	4.60	2.06	91.87	8.84	6.52	1.17	3.48
Average for all		962	4.58	2.15	89.06	8.78	6.25		4.01

PROGRESS OF INBRED LINES OF RAMBOUILLETS

Matings were made in 30 inbred lines during the year 1944-45. No lines were added or dropped during the year. The number of ewes remained practically the same. Two pens were included to test outside rams with promise of giving improvement for open face. These two pens functioned as test pens. Data on the various inbred lines are presented in the accompanying table.

Data on changes in inbreeding are not included this year as it has not been possible to calculate inbreeding coefficients for 1945 offspring yet. It appears that there will be a continued increase in the inbreeding of both dams and offspring. The proportion of inbred offspring increased from 60 percent in 1942, to 71 percent in 1943, to 81 percent in 1944, and to 88 percent in 1945.

The first 6 lines for each of the more important traits are listed in the following table for comparison with similar tables presented in previous years. These ranks are based on averages from weanling offspring in 1944.

Trait	1st	2nd	3rd	4th	5th	6th
Body weight	53	29	36	34	32	35
Body type	36	29	21	20	45	51
Staple length	45	47	20	21	34	37
Open face	40	50	53	35	44	51
Freedom from folds	44	47	23	45	19	51

Again slightly more than half of the lines are included in the table. Eleven of these lines were included last year and 6 were not. Lines 45 and 51 appeared 3 times. Nine lines (21,29,32,34,37,40,44, 47, and 51) have ranked in the high 6 for one or more traits for each of the last 4 years.

Since 1940 the age of ewes in Rambouillet inbred lines has steadily declined from an average of 4.42 to 4.01 years. This means a decrease in the generation interval for ewes, but also indicates that the proportion of young ewes saved for breeding has increased and that slightly more culling is being done on the older ewes.

USEFULNESS OF RAMBOUILLET FLOCK IMPROVED

Since the Laboratory was established, the Rambouillet flock has improved materially for smoothness. Only a small percentage of the mature ewes show wrinkles to any degree. The staple is uniformly longer, the open face is more in evidence and the lamb production has increased. The latter may be due to some extent to improved management. But the very hopeful thing is that there is still room for improvement in the flock, which when accomplished--and there is every evidence that the breed has the potential for such improvement--the Rambouillet breed will be very highly satisfactory sheep for the Western range.

LAMB PRODUCTION OF RAMBOUILLET FLOCK

Constant attention to lamb production is essential to determine if management is adequate and to maintain a high level of productivity of the ewe flock. Any increase in lamb production consistent with good range management provides a greater opportunity for selection and results in increased income. A summary of lamb production of Rambouillets for the past 21 years is presented in the following table:

Year	No. of lambs	Average weaning weight	Percent of lambs weaned, based on ewes bred	Pounds of lamb per ewe bred
1924-29	1790	72.28	69.83	50.47
1930-39	2294	68.06	72.93	49.63
1940	805	79.13	86.46	68.42
1941	850	76.20	92.94	70.82
1942	1023	75.09	93.35	70.09
1943	903	83.38	91.58	76.37
1944	908	75.17	94.27	70.86
1940-44	4489	77.66	91.87	71.35

A marked increase in lamb production has been noted in recent years, probably resulting largely from changes in management practices. Production for 1944 was very satisfactory. There was an increase in the percent of lambs weaned but a decrease in average weaning weight.

HERITABILITY OF FLEECE AND BODY TRAITS OF RAMBOUILLET SHEEP

Estimates of heritability presented in previous years have been based on offspring-dam regressions and half-sib correlations, but were not corrected for inbreeding. The effect of inbreeding and top-crossing inbred sires to noninbred ewes has been investigated more recently, and estimates of heritability, adjusted for inbreeding, have been calculated from data on more than 2000 weanling lambs.

The estimates for face covering score, staple length, and neck folds were 56, 40, and 39 percent, respectively. Those for body weight, type score, and condition score were 30, 13, and 4 percent, respectively.

Some applications of these values in the breeding program are given elsewhere in this report. They will be useful in deciding how much attention should be given the various traits so selection can be practised most wisely and consistently in attaining maximum rate of genetic improvement in economic merit. The development of selection indices will facilitate the attainment of these objectives.

Estimates of heritability will be useful in deciding at what age each trait should be emphasized in selection. Selections for highly heritable traits such as face covering, staple length, and neck folds can largely be made at weaning time on individual merit without waiting for progeny test information. Selection on lowly heritable traits, such as type and condition score,can best be done after progeny test information becomes available.

INCREASING THE ACCURACY OF SELECTION IN RAMBOUILLETS

The effect which sex, twinning, age of dam, age at weaning, and inbreeding have on weanling traits of Rambouillet lambs was presented last year. Data are now being adjusted for these differences so that individual merit and progeny performance can be compared more accurately.

Only the most important differences are being considered in adjusting each trait. Length of staple is corrected for sex, age of dam, and age at weaning. Body weight is corrected for sex, age of dam, twinning, age at weaning and percent inbreeding. Body type score is corrected for twinning, age at weaning, and percent inbreeding. Condition score is corrected for twinning and percent inbreeding. Neck folds score is corrected for twinning.

These corrections for environmental factors are intended to place the lambs on a basis comparable to what they would have been if all the lambs had the same sex, age of dam, age at weaning, etc. This procedure is expected to lead to greater genetic improvement because the corrected data will more closely represent actual breeding value than uncorrected data.

HERITABILITY OF FLEECE AND BODY TRAITS OF RAMBOUILLET SHEEP

Estimates of heritability presented in previous years have been based on offspring-dam regressions and half-sib correlations, but were not corrected for inbreeding. The effect of inbreeding and of mating inbred sires to noninbred ewes has been investigated more recently, and estimates of heritability, adjusted for inbreeding, have been calculated from data on more than 2000 yearling lambs.

The estimates for face covering score, staple length, and neck folds were 56, 40, and 35 percent, respectively. Those for body weight, type score, and condition score were 27, 13, and 4 percent, respectively.

Some applications of these values in the breeding program are given elsewhere in this report. They will be useful in deciding how much attention should be given the various traits so selection can be practiced most wisely and consistently in attaining maximum rate of genetic improvement in economic merit. The development of selection indexes will facilitate the attainment of these objectives.

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INCREASING THE ACCURACY OF SELECTION IN RAMBOUILLETS

The effect which sex, twinning, age of dam, age at weaning, and inbreeding have on weanling traits of Rambouillet lambs was presented last year. Data are now being adjusted for these differences so that individual merit and progeny performance can be compared more accurately.

Only the most important differences are being considered in adjusting each trait. Length of staple is corrected for sex, age of dam, and age at weaning. Body weight is corrected for sex, age of dam, twinning, age at weaning and percent inbreeding. Body type score is corrected for twinning, age at weaning, and percent inbreeding. Condition score is corrected for twinning and percent inbreeding. Neck folds score is corrected for twinning.

These corrections for environmental factors are intended to place the lambs on a basis comparable to what they would have been if all the lambs had the same sex, age of dam, age at weaning, etc. This procedure is expected to lead to greater genetic improvement because the corrected data will more closely represent actual breeding value than uncorrected data.

SELECTION PRACTICED ON RAMBOUILLET LAMBS

Selection intensity is an important measure of progress in the improvement of sheep. The most useful estimate of the selection intensity actually practiced in sheep improvement is the difference between the average of those selected over the average of the whole population in which they were born. This advantage of the selected group over the group in which they were born is usually referred to as the selection differential. Selection differentials for 6 traits measured in weanling lambs are shown in the following table for the inbred Rambouillet lines in 1944. The selection differential is greater for ram lambs than for ewe lambs for each of the six traits. This difference is consistent with the difference in intensity of selection in the two groups, since 23 percent of the ram lambs and 74 percent of the ewe lambs were retained in the selected groups.

		Face Covering	Staple length	Weanling weight	Type	Condition	Neck folds
		score	cm.	pounds	score	score	score
Rams	Advantage of selected lambs	.21	.17	4.98	.41	.26	.35
	Relative emphasis	.34	.37	.59	.85	.60	.45
	Expected genetic gain	.118	.068	1.494	.053	.010	.136
Ewes	Advantage of selected lambs	.05	.04	.79	.13	.04	.22
	Relative emphasis	.08	.09	.09	.27	.09	.29
	Expected genetic gain	.028	.016	.237	.017	.002	.086
Annual rate of improvement		.020	.011	.233	.009	.002	.030

It is evident that a greater selection differential can be obtained for traits which show considerable variation or "spread" than for traits where little variation exists. The emphasis given each trait when selection is practiced relative to the other traits, depends upon this variation as well as upon the selection differential for that trait. The relative emphasis for each trait was calculated by

SELECTION PRACTICED ON WEANLING LAMBS

Selection intensity is an important measure of progress in the improvement of sheep. The most useful estimate of the selection intensity actually practiced in sheep improvement is the difference between the average of those selected over the average of the whole population in which they were born. This advantage of the selected group over the group in which they were born is usually referred to as the selection differential. Selection differentials for 6 traits measured at weanling lambs are shown in the following table for the inbred Rambouillet lines in 1941. The selection differential is greater for ram lambs than for ewe lambs for each of the six traits. This difference is consistent with the difference in intensity of selection in the two groups, since 15 percent of the ram lambs and 74 percent of the ewe lambs were retained in the selected groups.

		Face Covering	Staple length	Weanling weight	Type	Condition	Neck folds
		score	cm.	pounds	score	score	score
Rams	Advantage of selected lambs	.21	.17	4.33	.41	.22	.46
	Relative emphasis	.24	.17	.59	.32	.09	.42
	Expected genetic gain	.118	.033	1.408	.032	.019	.133
Ewes	Advantage of selected lambs	.05	.04	.70	.13	.04	.21
	Relative emphasis	.08	[illegible]	.09	.27	.09	.12
	Expected genetic gain	.025	.016	.111	.017	.032	.038
	Annual rate of improvement	.030	.011	.202	.009	.005	.009

It is evident that a greater selection differential can be obtained for traits which show considerable variation or "spread" than for traits where little variation exists. The emphasis given each trait when selection is practiced relative to the other traits, depends upon this variation as well as upon the selection differential for that trait. The relative emphasis for each trait was calculated by

dividing the selection differential by the standard deviation for that trait. These figures indicate that greatest efforts were directed toward the selection of lambs having good type and smooth bodies. The least emphasis was placed on face covering and staple length.

It is also evident that the selection differential is not a true measure of genetic improvement expected from selection. Almost all, or almost none, of the selection differential may be transmitted from parent to offspring, depending upon whether a trait is highly or lowly hereditary. Consequently the genetic gain expected in selecting ram lambs and ewe lambs was obtained by multiplying the selection differential by the heritability for the corresponding trait. These figures are estimates of how much the selected group are superior in actual breeding value to the unselected groups from which they were chosen.

If no additional selections were practiced on these lambs, the annual rate of improvement would be the sum of the genetic improvement in the Ram lambs and ewe lambs divided by their average age when their offspring are born. Their average age when their offspring will be born can be approximated closely by the average age of their parents, which was 3.38 years for rams and 4.05 years for ewes. Thus the annual rate of improvement expected from selection on weanling traits is the sum of the genetic gain in ram lambs and ewe lambs divided by the total age, 7.43 years. It is evident from the figures given that any sensational improvement in a short period of time is unlikely.

Some additional improvement is to be expected from subsequent selection on yearling performance and progeny test information among the 23 percent of the ram lambs which were retained. Additional improvement among the ewes will be negligible since about 72 percent of the ewe lambs weaned must go into breeding to maintain flock numbers, and subsequent selections are largely based on soundness and fertility. Four percent of the ram lambs weaned in 1942 were used in lines through the 1944 breeding season. The selection advantages of these rams were .54 for face covering, .18 for staple length, 8.32 for weaning weight,.54 for type score and .61 for neck folds score. The emphasis was greatest for type score, followed by face covering, neck folds, weaning weight, and staple length.

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If no additional selections were practiced on these lambs, the annual rate of improvement would be the sum of the genetic improvement in the ram lambs and ewe lambs divided by their average age when their offspring are born. Their average age when their offspring will be born may be approximated closely by the average age of their parents, which was 3.78 years for rams and 4.05 years for ewes. Thus the annual rate of improvement expected from selection on weanling traits is the sum of the genetic gain in ram lambs and ewe lambs divided by the total age, 7.83 years. It is evident from the figures given that any sensational improvement in a short period of time is unlikely.

Some additional improvement is to be expected from subsequent selection on yearling performance and progeny test information among the 28 percent of the ram lambs which were retained. Additional improvement among the ewes will be negligible since about 72 percent of the ewe lambs weaned must go into breeding to maintain flock numbers, and subsequent selections are largely based on soundness and fertility. Four percent of the ram lambs weaned in 1952 were used in flocks through the 1954 breeding season. The selection advantages of these rams were .54 for face covering, .18 for staple length, 2.52 for weaning weight, .51 for type score and .83 for neck folds score. The emphasis was greatest for type score, followed by face covering, neck folds, weaning weight, and staple length.

EFFECTIVENESS OF PROGENY TESTING IN SHEEP

An analysis of the factors which contribute to the annual rate of genetic improvement showed that the use of progeny-tested sires most effictively supplements earlier culling on phenotypic performance when (1) the reproductive rate is low, (2) the average length of generation is long, and (3) heritability is low. These factors which hamper rapid progress and increase the effectiveness of progeny testing are all present to some extent in sheep.

It was found that the progeny test could by no means be recommended indiscriminately for improving all kinds of livestock or even for all traits in those kinds where it was best suited. While increased accuracy usually accompanies progeny testing, this increase may not always be sufficient to offset the automatic increase in length per generation incurred by using progeny-tested rams.

For example, the use of progeny-tested sires is effective in increasing progress for a trait with heritability of 30 percent,such as weaning weight, when the trait can be measured on the offspring as lambs. However, the rate of progress is actually decreased as compared with what could be accomplished by phenotypic selection alone if a trait like fleece weight cannot be measured on the offspring until they are yearlings. This difference in effectiveness is due solely to the additional time required in the latter example to obtain and put into effect the progeny test information. Where heritability is 10 percent, progeny testing can increase the rate of progress by as much as 20 percent, provided rams can be tested on an auxiliary flock of ewes.

The investigation to date indicates that a general program of the following kind should be most effective in attaining maximum rate of improvement in economic efficiency: (1) Select ram lambs for the most highly hereditary traits; i.e., face covering, neck folds, and weaning weight. (2) Select yearling rams for additional highly hereditary traits measured at yearling age; i.e., staple length and fleece weight. (3) Test two or three rams for each one used, selecting the best ram on the basis of his progeny performance, paying particular attention to the traits having least heritability; i.e., type and condition. (4) Use an untested ram which appears to be good in preference to a tested ram which has been proved poor. (5) Cull ewe lambs and yearling ewes lightly so that most of the selection in ewes can be made for lamb production on the basis of their performance as 2-year-old ewes.

Several factors must be examined in greater detail before a final program can be recommended. For example, the most effective compromise between testing few rams on a large number of offspring and testing several rams for each one eventually used has yet to be worket out. However, enough work has been done to make clear the most effective general program and the additional information is being obtained as rapidly as possible.

SELECTION FOR SMOOTHNESS IN RAMBOUILLETS

Efforts to eliminate skin folds from the Laboratory flock have been very successful. These efforts have been given precedence over some other breeding problems as it was felt essential to develop only lines that were smooth or free from skin folds. The flock is now rapidly nearing the point where further emphasis on skin folds will be less necessary. Thus, one goal in the improvement of Rambouillets will be achieved rather early in the breeding program. When it is accomplished, it will permit increased attention to other traits such as body weight, fleece weight, staple length and face covering.

The gain in smoothness in one generation has been approximately 0.5 of one score. That is, the average neck fold score of all weanling offspring from inbred lines has changed from 2.2 to 1.7 in about 4 years. A score of 1 represents complete absence of folds while a score of 5 indicates maximum skin fold development. The percent of weanling lambs showing moderate to heavy folds has decreased from about 35 percent in 1938-40 to about 15 percent in 1942-44. Furthermore those lambs with practically no folds have increased from 28 to 58 percent in the same period.

These gains represent the maximum improvement which would be expected from the values for heritability, selection differential, and rate of selection which apply to this flock if skin folds were the only trait considered. Thus, the actual progress has been somewhat greater than would be expected, as considerable attention in selection has been given to other traits. Reasons for this rapid progress are not entirely clear. The expected improvement may be too low as it is estimated from a normal curve while the frequency distribution for folds score is skewed. Results from progeny tests have also been used in selecting for smoothness which should increase the progress over selection on individual merit alone. On the other hand, score for skin folds is a subjective measure which is apt to change in standard from year to year. It is expected that this change would be in the direction to indicate more, rather than less, folds than actually exist as the flock becomes smoother. Any change in standard in this direction would cause an underestimation of the actual improvement made. Another factor may be that the heritability of neck folds is now less than it was several years ago. This is to be expected if the frequency of the genes causing folds is becoming quite low.

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The gain in smoothness in one generation has been approximately 0.6 of one score. That is, the average neck fold score of all weanling offspring from inbred lines has changed from 2.3 to 1.7 in about 4 years. A score of 1 represents complete absence of folds while a score of 5 indicates maximum skin fold development. The percent of weanling lambs showing moderate to heavy folds has decreased from about 55 percent in 1938-40 to about 15 percent in 1942-44. Furthermore those lambs with practically no folds have increased from 35 to 60 percent in the same period.

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INEQUALITIES IN THE JAWS OF SHEEP

A study of overshot jaws in sheep has been conducted over a period of more than 7 years. Sheep with overshot jaws had longer skulls and shorter mandibles than normal animals. The mandible was affected along its entire length, but the space occupied by the molar teeth was less affected than the remainder of the jaw. The maxilla was the only structure of the upper jaw that was appreciably longer in overshot ewes than in normal ewes and again it was affected much more than the molar space.

Linear skull measurements were more variable in overshot than in normal animals, reflecting greater general disharmony in skeletal structures of defective animals. However, positive correlations were found between upper and lower jaw structures in both overshot and normal groups indicating that general factors are important in determining variation in different skeletal structures despite the disharmony evinced by the overshot condition. There is no conclusive evidence that the angle of the mandible was disturbed by the overshot condition.

A tendency was apparent in normal animals for the angles of the incisor teeth to compensate for inequalities of the jaws. These angles in normal sheep were inversely correlated with mandible length and were much more variable in normal than in overshot animals. This tendency to compensate was absent in the overshot animals studied.

Marked inequality of the upper and lower jaw occurred in about 1.4 percent of the offspring from a large flock of normal Rambouillet sheep. Experimental matings in which one or both parents were overshot produced 16.4 percent defective offspring. Defective lambs were slightly smaller than normal but no reduction in viability to weaning age was apparent. Inequality of the jaws was found to increase from birth to weaning to yearling age.

The occurrence of the overshot condition from matings of normal parents suggested a simple recessive inheritance of the defect. However, this hypothesis was refuted when the mating of defective rams with defective ewes gave too few defective offspring. When defective rams were mated with normal and overshot daughters, a significantly greater proportion of defective offspring were obtained from the overshot daughters indicating that they were genetically different from the normal daughters. Furthermore, three groups of defective dams were found to be genetically different, since the probability of obtaining defective offspring decreased with the relationship of sire and dam. This indicates that interactions of several pairs of genes were probably involved. Some of these genes were most certainly dominant and additional recessive genes could have been involved.

IRREGULARITIES IN THE JAWS OF SHEEP

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Linear skull measurements were more variable in overshot than in normal animals, reflecting greater general disturbance in skeletal structures of defective animals. However, positive correlations were found between upper and lower jaw structures in both overshot and normal groups indicating that general factors are important in determining variation in different skeletal structures despite the disharmony evinced by the overshot condition. There is no conclusive evidence that the angle of the mandible was disturbed by the overshot condition.

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Marked irregularity of the upper and lower jaw occurred in about 1.6 percent of the offspring from a large flock of normal Rambouillet sheep. Experimental matings in which one or both parents were overshot produced 10.4 percent defective offspring. Defective lambs were slightly smaller than normal but no reduction in viability to weaning age was apparent. Inequality of the jaws was found to increase from birth to weaning to yearling age.

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POLLED RAMBOUILLETS

Polled rams were again mated to polled ewes and ewes with horn knobs and scurs, all of which were sired by horned rams. Through 1944 a total of 151 lambs (excluding wethers) have been weaned from those polled lines. Frequency of offspring in the various classes from the different matings are shown in the following table:

Parents	Offspring			
	Horned rams	Polled rams	Ewes with knobs	Polled ewes
Horned rams X polled ewes	6	10	11	14
Polled rams X ewes with knobs	4	2	5	4
Polled rams X polled ewes	6	35	13	41

Polled rams may or may not have had scurs. All parents were sired by horned rams. These results are consistent with Warwick's theory that horns in rams and horn knobs in ewes are due to one pair of recessive genes.

The following breeding program is suggested to fix the polled trait as quickly as possible:

1. Test or use the best polled ram lambs as much as possible until a homozygous polled ram with acceptable body and fleece is discovered.

2. Test sufficient of the best polled offspring of the homozygous polled ram so that reserve tested homozygous rams will usually be available from then on.

3. Cull only the poorest ewes with horn knobs each year plus ewes culled for unsoundness, low fertility, and age down to the desired number for the pen.

4. When the pen is made up entirely of polled ewes, cull the ewes known to be heterozygous first, that is those that were sired by horned rams or out of ewes with horn knobs or those which have produced horned male offspring or ewe offspring with knobs.

5. When the pen is made up entirely of polled ewes none of which are known to be heterozygous, cull first those, whose mothers were known to be heterozygous.

REPRODUCTIVE CAPACITY OF RAMS AS INDICATED BY SEMEN TESTS

Semen tests were again made on all breeding rams in 1944. A total of 415 ejaculates were examined from 111 rams. Of these, 89 rams were used in breeding pens. Only 8 rams were rejected because of poor quality semen. The semen produced appeared to be considerably better in quality than in 1943.

All rams used in pens sired offspring. It appears that with the exception of one ram lamb that all of the rams used were of satisfactory fertility.

Preliminary tests have been made on the use of a photoelectric colorimeter for the determination of sperm concentration. Data have been collected for use in developing a standard method and to work out curves by which the colorimeter readings may be transformed to concentrations of spermatozoa. Analyses of these data are not yet complete.

LENGTH OF GESTATION IN RANGE SHEEP

An analysis of the factors affecting length of gestation is now nearly complete. Rambouillets had the longest gestation periods with an average of 151.4 days followed in order by Corriedales with 149.6 days, Targhees with 149.4 days and Columbias with 148.4 days.

Other factors affecting the length of gestation were studied on 1638 periods from Rambouillet ewes. These periods ranged from 143 to 159 days in length with a mean of 151 days and a standard deviation of 2.25 days. Variation between sires was highly significant. Ewes that were bred early tended to have significantly, but slightly longer gestation periods than those that were bred late. There was an average decrease of .03 day in length of gestation with the progress of each day in the breeding period. A definite increase in the length of gestation with advancing age of the ewe was shown by an average increase of .27 day for each year of age. The effect of the weight of the ewe on gestation length was positive but not significant.

Gestation periods for twin lambs averaged .4 day shorter than those for single lambs. This difference was highly significant. The average gestation period for ram lambs was identical with that for ewe lambs. It appears that greater milk production is a consequence of longer gestation periods as there was a significant relationship between the rating of milk production of the ewe at the time of birth and the duration of the gestation period.

Lambs which were recorded as hairy at birth were born from slightly longer gestation periods than those which were not hairy. The mean difference of 0.5 day was barely significant. Only a small proportion of the total lambs born were included in the hairy group.

A significant relationship was found between the length of gestation and viability of the lamb as measured by the percent lambs weaned of lambs born. With each day increase in the length of gestation there was an average increase of 1.3 percent of single lambs weaned and 0.6 percent of twin lambs weaned. The relationship was not strictly linear as there was a tendency for the curves to level off after 152 days for twin lambs and 154 days for single lambs. In general, gestation periods slightly above average in length were more favorable for survival of the lamb.

BIRTH WEIGHT OF RAMBOUILLET LAMBS

Data on the birth weight of over 10,000 Rambouillet lambs gave an average of 9.85 pounds. There was a variation of slightly more than a pound in yearly averages, over a 7 year period. There was a definite interaction between type of birth and sex on birth weight. Single ram lambs averaged 10.74 pounds while single ewe lambs averaged 10.04 pounds. Ram lambs twinned with ewe lambs averaged 9.40 lbs. while ram lambs twinned with ram lambs averaged 9.18 pounds. Ewe lambs twinned with ewe lambs averaged 8.77 pounds as compared with 8.61 lbs. for ewe lambs twinned with ram lambs. It appears that the birth weight of a lamb is not only affected by its sex but also by the sex of the lamb with which it is twinned. The sex difference in birth weight was greater for twins of unlike sex than for single lambs and was least between twins of like sex. Total weight was greatest for twin ram lambs and least for twin ewe lambs while twins of unlike sex were intermediate.

WOOL PRODUCTION OF RAMBOUILLET YEARLING EWES

Summaries of wool production of Rambouillet yearling ewes for the past 5 years are given in the accompanying table.

Improvement over 1943 was noted in the averages for 1944 in every character except staple length and here the change was slight. However, none of the values were maximum for the five year period.

Caution must be used in attributing any change over a period of a few years in wool production to genetic change as a result of selective breeding. Annual variations resulting from environmental effects will usually overshadow genetic changes. Furthermore, yearling records are made after some selection has been practiced which reduces their value in measuring genetic improvement. It appears probable that at least a part of the definite trend toward greater length of staple may be genetic but it is possible that none of it is. For instance yearling ewes in 1943 show a gain of .34 cm. over the previous year, but at weaning time they had been .27 cm. shorter. The yearling ewes in 1943 represent 54 percent of the

A significant relationship was found between the length of gestation and viability of the lamb as measured by the percent lambs weaned of lambs born. With each day increase in the length of gestation there was an average increase of 1.4 percent of single lambs weaned and 0.8 percent of twin lambs weaned. The relationship was not strictly linear as there was a tendency for the curve to level off after 150 days for twin lambs and 152 days for single lambs. In general, gestation periods slightly above average in length were more favorable for survival of the lamb.

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weanling ewes they were selected from, while those the previous year represented 86 percent of the weanling ewe population. Thus the genetic change from 1942 to 1943 could have been slightly negative although the yearling values show a definite gain.

SUMMARY OF WOOL PRODUCTION FOR 1944 AND FOUR PRECEDING YEARS FOR RAMBOUILLET YEARLING EWES
(Adjusted to 365 days growth)

Years	1944	1943	1942	1941	1940
Fleece Characters	Mean	Mean	Mean	Mean	Mean
Fleece weight (grease) lbs.	8.61	8.05	7.89	9.34	9.12
Fleece weight (clean) (bone dry) lbs.	3.51*	3.18*	3.52	3.40	4.10
Commercial for breed	3.99	3.61	4.00	3.86	3.52
Clean Yield (bone dry) %	40.77	39.87	44.61	36.43	33.97
Commercial for breed	46.30	45.31	50.7	41.4	38.6
Staple length (cm.)	6.42	6.47	6.13	5.99	5.68
Staple length (inches)	2.53	2.55	2.41	2.36	2.24

* Estimated from nomograph by use of grease fleece weight and staple length.

LONG STAPLE LINE

Summaries of wool production (adjusted to 365 days) for yearling ewes from line 21 originally selected for long staple are given in the following table:

Year	No. of head	Staple length (cms.)	Staple length (inches)	Grease fleece weight (lbs.)	Clean fleece weight (lbs.)
1939	11	6.51	2.56	9.30	3.14
1940	16	6.78	2.67	9.55	3.81
1941	8	6.63	2.61	10.21	3.76
1942	7	7.21	2.84	8.05	3.98
1943	7	7.56	2.98	7.43	3.40
1944	7	7.09	2.79	8.19	3.60

These values may be compared with those in the preceding table for all lines. It is apparent that line 21 may be slightly below average in grease fleece weight but is definitely above average in clean fleece weight.

Changes in staple length have closely paralleled those of the entire flock. The advantage of line 21 over all lines has remained fairly constant, varying from .64 to 1.10 centimeters or .25 to .43 inches. This indicates that the gain in staple length made in the selection of the foundation sheep for the line has been maintained.

In 1944, 6 of the yearling ewes produced fleeces grading Fine Staple Combing and 1 graded ½ Blood Combing.

THE NEED OF APPLYING SHRINKAGE STUDIES TO INDUSTRY IS URGENT

The wool marketing practice is one of the most primitive of all marketing practices of agricultural products. When we sell wheat that is worth 2¢ per pound we are especially concerned that we get value received. The wheat is tested in order that we may know how much wheat is in the bag, apart from chaff. When we market wool that is worth $1.00 per pound, or fifty times as much as wheat, we guess at the amount of wool in the bag, apart from the dirt, etc. The following table shows the influence of shrinkage overestimations on the net returns of wool in a 10 lb. fleece when clean wool is selling at $1.00 per pound:

Overestimation of shrink in percent	Net loss in 10 lb. fleece
1	$ .10
2	.20
3	.30
4	.40
5	.50

For each additional overestimation of 1% shrinkage add another $ .10 to the net loss in the 10 pound fleece.

The above losses due to the overestimation of shrinkage are net losses and would constitute in some years the total net return The overestimation of shrinkage particularly among the above average flocks in the West is very common and constitutes a terrific discouragement for the sheep man who would like to make improvement in his flocks. In a study of shrinkage overestimations of the clip at this Laboratory during the years when the clip was sold on the basis of estimated shrink, we find some outstanding examples of net loss due to overestimation in shrink.

COMPARISON OF ESTIMATED WITH ACTUAL SHRINKAGE IN RAMBOUILLET WOOL

	Estimated			Actual	
	Ewe wool	Ram wool		Ewe wool	Ram wool
1940	66 %	70%		*61 %	
1941	63-65%	67%		*59 %	
1942				55 %	53%
1943				55 %	54%
1944			(Core test only)	53.3%	53%

* Result of small samples shrinkages in this Laboratory.

It is somewhat difficult to explain why the shrink was uniformly high in 1940 and 1941 and that it was uniformly low for the three consecutive years. If the small sample shrinkages were correct in 1940 and 1941, the net loss per fleece to this Station was 50 cents or more - more for fleeces that exceeded 10 pounds in weight.

This information offers the most fruitful opportunity for helpfulness to the wool grower today. Its application to field conditions will yield immediate response. There is very general complaint that the sheepmen are not getting value received, and from actual field contacts made by personnel of this Laboratory, the growers are extremely anxious to get some help.

COMMERCIAL GRADES AND WEIGHTS OF 1944 FLEECES

The distribution of fleeces and average fleece weights for each grade are given in the accompanying tables. The predominant grade was Fine Staple for Rambouillets, 1/2 Blood for Targhees and 3/8 Blood for Columbias and Corriedales. A higher proportion of Columbia fleeces graded 1/4 Blood than of the Corriedales. The distribution of ram fleeces was very similar to that for ewe fleeces. In general, clean fleece weight increased in the coarser and longer staple grades.

COMMERCIAL GRADES AND WEIGHTS OF 1944 EWE FLEECES

	MATURE EWES					YEARLING EWES				
	Fine French Combing	Fine Staple Combing	1/2 Blood Combing	3/8 Blood Combing	1/4 Blood Combing	Fine French Combing	Fine Staple Combing	1/2 Blood Combing	3/8 Blood Combing	1/4 Blood Combing
RAMBOUILLET										
No. of fleeces	558	951	49			14	379	18		
% in each grade (%)	35.8	61.0	3.2			3.4	92.2	4.4		
Ave.gr.fl.wt. (lbs.)	9.66	10.03	10.39			8.50	9.51	9.90		
Ave.cl.fl.wt. (lbs.)	4.45	4.74	5.38			3.92	4.40	4.64		
TARGHEE										
No. of fleeces	6	44	178	16	3		13	71	11	
% in each grade (%)	2.4	17.8	72.1	6.5	1.2		13.7	74.7	11.6	
Ave.gr.fl.wt. (lbs.)	8.35	9.87	9.79	10.65	9.93		9.03	9.63	10.61	
Ave.cl.fl.wt. (lbs.)	3.85	4.67	5.07	5.70	5.58		4.18	4.52	5.06	
CORRIEDALE										
No. of fleeces		3	15	68	11		1	3	19	4
% in each grade (%)		3.1	15.5	70.1	11.3		3.7	11.1	70.4	14.8
Ave.gr.fl.wt. (lbs.)		10.08	10.02	9.58	11.72		8.00	9.13	9.33	10.25
Ave.cl.fl.wt. (lbs.)		4.77	5.19	5.13	6.59		3.70	4.28	4.45	5.37
COLUMBIA										
No. of fleeces		1	30	287	208			11	111	32
% in each grade (%)		.2	5.7	54.6	39.5			7.1	72.1	20.8
Ave.gr.fl.wt. (lbs.)		8.35	10.34	10.79	11.76			9.65	10.08	11.80
Ave.cl.fl.wt. (lbs.)		3.95	5.36	5.77	6.61			4.53	4.81	6.18

COMMERCIAL GRADES AND WEIGHTS OF 1944 RAM FLEECES

	MATURE RAMS					YEARLING RAMS				
	Fine French Combing	Fine Staple Combing	1/2 Blood Combing	3/8 Blood Combing	1/4 Blood Combing	Fine French Combing	Fine Staple Combing	1/2 Blood Combing	3/8 Blood Combing	1/4 Blood Combing
RAMBOUILLET										
No. of fleeces	3	98				2	103			
% in each grade (%)	3.0	97.0				1.9	98.1			
Ave.gr.fl.wt. (lbs.)	11.97	16.43				9.53	12.21			
Ave.cl.fl.wt. (lbs.)	5.52	7.77				4.39	5.78			
TARGHEE										
No. of fleeces			30	2	2		8	41	8	
% in each grade (%)			88.2	5.9	5.9		14.0	72.0	14.0	
Ave.gr.fl.wt. (lbs.)			16.62	16.85	16.32		11.94	13.86	14.53	
Ave.cl.fl.wt. (lbs.)			7.89	8.61	8.00		5.65	6.58	7.42	
CORRIEDALE										
No. of fleeces			1	18	2		1	5	15	2
% in each grade (%)			4.8	85.7	9.5		4.4	21.7	65.2	8.7
Ave.gr.fl.wt. (lbs.)			13.80	15.51	15.10		10.80	12.80	12.72	13.25
Ave.cl.fl.wt. (lbs.)			6.56	7.93	7.40		5.11	6.08	6.50	6.49
COLUMBIA										
No. of fleeces			1	20	6			4	30	12
% in each grade (%)			3.7	74.1	22.2			8.7	65.2	26.1
Ave.gr.fl.wt. (lbs.)			15.00	16.98	19.32			12.00	14.22	15.53
Ave.cl.fl.wt. (lbs.			7.13	8.68	9.47			5.70	7.27	7.61

SHRINKAGE AND APPRAISAL VALUES FOR 1944 CLIP

Estimated shrinkage and appraisal values for the various lots of the 1944 wool clip are presented in the accompanying table. In general, in the larger lots, the shrinkage estimated by the appraiser exceeded that estimated from a core sample. In the yearling wool and in the coarser ram wool the shrinkage was estimated by the appraiser to be lower than that obtained from core samples.

Shrinkage and appraisal values on Graded and sorted Clip for 1944

Grade	Est. Shrinkage (%)	Shrinkage** from core samples (%)	Value* Clean (per lb.)	Boston Grease (per lb.)
			$	¢
EWES:				
Fine French Combing	57	53.9	1.19	51.17
Fine Staple "	54	52.7	1.21	55.66
1/2 Blood "	50	48.2	1.19	59.50
3/8 Blood "	48	46.5	1.08	56.16
1/4 Blood "	45	43.8	.98	53.90
YEARLINGS:				
Fine Staple Combing	53	53.7	1.20	56.40
1/2 Blood "	52	53.1	1.19	57.12
3/8 Blood "	50	52.3	1.08	54.00
1/4 Blood "	47	47.6	.98	51.94
RAMS:				
Fine Staple Combing	55	52.7	1.20	54.00
1/2 Blood "	53	52.5	1.19	55.93
3/8 Blood "	48	48.9	1.08	55.08
1/4 Blood "	50	51.0	.98	49.00
MISCELLANEOUS LOTS:				
Fine Crutchings		59.1	.61	25.00
X - Bred Crutchings		51.0	.55	27.00
Corral Sweeps		67.1	.46	15.00
Black (mixed)		55.3	.78	35.00

*Appraisal values as reported by C.C.C.

**Core samples and shrinkages were taken and made by the Office of Marketing Services, War Food Administration.

HIGH PRODUCTION OF WOOL PER UNIT IMPORTANT

Since emphasis was placed upon the selection for longer staple wool, for smoother sheep--which seems to favor length of staple--there has been a consistent increase in length of staple produced until in the Rambouillet flock of this Laboratory between 60 and 70 percent of the total clip was staple wool. The difference in yield per fleece of clean wool was approximately one pound over and above the shorter staple wool. This advance can be accomplished through selection in ewes and rams for this quality--a method that is readily accessible to the ranch wool producer. A difference of one pound of clean scoured wool represents a difference of about $1.00 per ewe. A production difference of one pound, or from 4 to 5 pounds, does not represent only an increase of 25 percent gross returns; inasmuch, as the improvement can be made at comparatively small cost. This increase in clean wool is very largely a net increase, and in many years, would mean the difference between profit and loss in wool production.

CLEAN WOOL YIELD DETERMINATIONS

A total of 517 samples were scoured during the year from 121 yearling ewes and 396 yearling and mature rams. These samples were scoured by the staff at the wool laboratory at Beltsville, Maryland because wool technologists were not available at Dubois. Percentage clean yield in the small side sample was used in determining the total amount of clean wool in each fleece.

Clean fleece weights of yearling ewes were again estimated from grease fleece weights and staple lengths. The average clean fleece weight of yearling Rambouillet ewes estimated by this method was identical to that estimated from core samples.

WOOL QUALITY

Wool samples were taken from yearling ewes and rams for the determination of fineness, uniformity and medullation. No determinations were made because of the absence of wool technologists. The samples will be retained for possible use in special or other studies at a later date.

PROGRESS IN DEVELOPING LINES OF COLUMBIA, TARGHEE, AND CORRIEDALE SHEEP

Matings of Columbias were continued in 10 lines and 4 test pens in the fall of 1944. The total number of ewes bred increased from 546 in 1943 to 599 in 1944. Of these 104 were mated in test pens and 117 in line crosses leaving a total of 378 ewes for the 10 inbred

SUMMARY OF EWES IN COLUMBIA BREEDING PENS
1944-45 Breeding Season

Pen no.	Ram no.	Kind of mating	No. of head	Face cov. score	Type score	Yearling body wt. (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbreeding coefficient dams (%)	Age of ewes at lambing (years)
1	3264K	Line	23	2.33	1.90	98.48	10.09	9.31	7.10	3.91
		Line crosses	30	2.27	1.86	101.20	10.00	9.45	3.62	3.93
1	4388K	Line	23	2.26	1.85	102.17	9.75	9.15	5.84	4.17
		Line crosses	29	2.37	1.86	100.62	9.55	9.37	5.43	3.48
2	4018K	Line	27	2.06	2.06	98.67	9.73	9.43	11.09	4.07
3	4263K	Line	40	2.30	1.80	101.68	10.77	9.44	4.82	3.60
4	3546K	Line	31	2.37	2.00	98.39	9.88	9.78	3.69	3.26
5	3435K	Line	27	2.31	1.91	90.96	9.20	8.85	4.98	3.22
		Line crosses	29	2.27	1.93	99.86	10.24	9.32	4.26	4.17
5	4048K	Line	29	2.30	1.90	97.41	9.45	9.74	4.64	3.55
		Line crosses	29	2.12	1.91	99.62	10.32	9.28	3.70	4.14
6	3522K	Line	28	2.31	1.69	99.07	10.07	8.90	4.23	4.00
7	4265K	Line	43	2.40	1.82	98.37	9.78	8.76	7.84	3.81
8	4970K	Line	26	2.37	1.92	97.92	9.89	8.84	4.33	3.96
9	4444K	Line	42	2.37	1.86	96.76	10.09	8.90	4.42	3.95
10	4883K	Line	39	2.34	1.98	95.18	9.64	8.42	3.74	4.18
Average for line pens			495	2.30	1.89	98.82	9.90	9.16	5.19	3.84
11	4401K	Test	27	2.63	2.03	95.70	9.89	9.16	0	4.93
12	4400K	Test	26	2.36	2.06	94.27	10.07	8.91	.56	6.23
13	4547K	Test	25	2.39	2.01	96.24	9.51	8.83	.56	5.16
14	3869K	Test	26	2.35	1.98	97.38	10.38	9.16	0	5.77
Average for test pens			104	2.43	2.02	95.89	9.98	9.02	.28	5.52

SUMMARY OF EWES IN TARGHEE BREEDING PENS
1944-45 Breeding Season

Pen no.	Ram no.	No. ewes.	Face cov. score	Type score	Yearling body wt. (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbr. coef. dams (%)	Age of ewes at lambing (years)
1	1587T	28	3.32	1.98	90.32	8.92	7.14	8.77	4.79
2	1783T	27	3.31	1.86	87.85	8.71	8.27	10.03	3.92
3	2585T	33	3.64	2.01	89.30	9.22	7.37	4.78	3.76
4	2082T	44	3.29	1.96	89.73	8.95	7.88	.68	3.84
5	2783T	33	3.41	2.08	86.82	8.91	7.78	6.82	4.54
6	2574T	30	3.33	1.89	91.33	9.60	8.30	2.64	4.10
7	2720T	27	3.36	2.12	87.26	9.27	7.71	8.19	4.56
8	2634T	35	3.46	2.08	90.97	9.63	7.91	4.22	4.83
9	2491T	27	3.54	1.89	90.70	9.11	8.61	.02	2.74
10	2830T	26	3.36	1.81	90.62	9.02	8.06	.05	2.77
Average for all		310	3.40	1.97	89.51	9.14	7.89	5.09	4.01

SUMMARY OF EWES IN CORRIEDALE BREEDING PENS
1944-45 Breeding Season

Pen no.	Ram no.	No. ewes.	Face cov. score	Type score	Yearling body wt. (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbr. coef. dams (%)	Age of ewes at lambing (years)
1	3959A	27	2.95	2.15	88.04	9.42	9.18	6.45	4.59
3	3666A	25	2.89	2.41	84.84	9.76	9.98	5.60	4.96
4	4289A	27	2.82	2.30	81.81	9.31	9.34	7.06	4.52
5	4108A	27	2.95	2.17	83.59	8.41	9.28	4.40	4.48
Average for all		106	2.90	2.25	84.57	9.21	9.43	5.88	4.63

lines. Some data on the various lines and test pens are listed in the accompanying table.

There was further increase in the average inbreeding coefficient of Columbia dams (from inbred lines) from 4.79 percent in 1943-44 to 5.19 percent in 1944-45. There was an increase in the average age of the ewes in both lines and test pens.

Targhees were bred in 8 lines and 2 test pens (9 and 10) in the fall of 1944 as shown in the accompanying table. The number of ewes included increased from 252 in 1943 to 310 in 1944. The average age of the ewes bred increased to an average of 4 years in spite of the

fact that an additional test pen of young ewes was added. The average inbreeding coefficient of the dams increased from 3.03 percent in 1943-44 to 5.09 percent in 1944-45.

Efforts to increase the numbers of Targhees were continued last fall. About 320 Rambouillet ewes were mated to Columbia rams, the offspring to be top-crossed with Targhee rams. Targhee rams were not mated to Rambouillet ewes this year as the results of the first years work (see Breed Crosses) indicated that for the first cross the Columbia x Rambouillet mating was more desirable than the Targhee x Rambouillet.

Corriedale matings were continued in 4 lines in 1944-45 as listed in the accompanying table. The average percent inbreeding for the dams increased from 4.63 to 5.88. The average age of the ewes bred again increased to 4.63 years.

LINE CROSSES IN COLUMBIAS

Preliminary results are available on crossing lines of Columbia sheep. Two sires each from lines 1 and 5 were mated with ewes from those lines and from lines 3, 4, 6, and 8. Ewes from the various lines were sorted out by the use of random numbers.

A total of 246 lambs were weaned in 1944 from the 6 lines and the crosses. The average inbreeding coefficient of the straight line offspring was 11.8 percent as compared with 6.7 percent for the crossline offspring. Weanling traits of the two groups are compared in the following table:

	No. of lambs	Staple length (cm.)	Body weight (pounds)	Type score	Condition score
Cross line	101	5.21	84.57	1.71	1.78
Straight line	145	5.05	83.89	1.76	1.92

These averages were obtained after adjustments had been made for sex, (to ewe lambs), age at weaning (to 120 days), twinning (to single lambs), age of dam (to mature dam) and inbreeding (to zero inbreeding).

On the average the cross-line offspring were slightly superior to the straight-line offspring for each trait. Analysis of the data has not yet been completed.

Summaries of data from lambing and weaning show that the lamb production was greater for the cross-line ewes. Cross-line ewes weaned nearly 4 percent more lambs and had an average production of about 5.4 pounds more of lamb weaned per ewe bred than the straight-line ewes.

BREED CROSSES

Columbia and Targhee Rams were mated to Rambouillet ewes in the fall of 1943 to provide ewe lambs which could be graded up by top crossing to Targhee rams. Rambouillet test ewes were divided at random and bred to 4 Columbia, 4 Targhee, and 13 Rambouillet rams. Weanling data (age at weaning was about 114 days) on the offspring are presented in the following table:

	No. head	Birth weight (lbs.)	Face cov. (score)	Staple length (cm.)	Body weight (lbs.)	Type score (score)	Condition score (score)	Neck folds (score)
EWE LAMBS								
Columbia X Rambouillet	79	10.54	3.60	3.70	74.51	2.03	1.96	1.34
Targhee X Rambouillet	80	9.55	4.27	3.40	66.09	2.31	2.34	1.56
Rambouillet	125	9.67	4.25	3.09	66.31	2.54	2.51	1.39
WETHER LAMBS								
Columbia X Rambouillet	66	10.91	3.97	3.36	75.11	2.16	2.27	1.52
Targhee X Rambouillet	76	10.47	4.50	3.26	70.49	2.27	2.39	1.71
Rambouillet	124	10.64	4.47	2.97	69.11	2.55	2.53	1.80

Offspring of Columbia rams X Rambouillet ewes were superior in every trait to the other two groups. In general they were also superior to straight Targhee lambs, presumably at least partly because of hybrid vigor, with the exception of staple length and freedom from folds. The percent of lambs weaned per ewe bred was greater for Targhee sires (98.2) than for Columbia sires (93.1).

Rambouillet lambs were heavier at birth than Targhee-Rambouillet crossbreds, while at weaning time the Rambouillet ewe lambs were slightly heavier and the ram lambs a little lighter. Targhee-Rambouillet crossbreds were superior to Rambouillets in length of staple, type and condition scores, and freedom from neck folds. There was little difference in the two groups in face covering.

From selection at weaning time 81 percent of the Columbia-Rambouillet crossbred ewe lambs, 75 percent of the Targhee-Rambouillet crossbreds, and 73 percent of the Rambouillet ewe lambs were saved for breeding.

It appears from the results of the first cross that the mating of Columbia rams to Rambouillet ewes is more desirable than mating Targhee rams to Rambouillet ewes for producing foundation Targhee ewe stock. However, neither cross in this trial produced length of staple or smoothness equal to straight Targhee lambs.

EFFECT OF INBREEDING ON COLUMBIA, TARGHEE, AND CORRIEDALE SHEEP

A study of the effect of inbreeding on weanling traits was made on 478 Columbia, 366 Targhee, and 238 Corriedale lambs born in 1941 and 1942. The changes in each trait with each one percent increase in inbreeding for the various breeds are shown in the following table:

Breed	Average change with each 1% increase of inbreeding in:			
	Body weight (lbs.)	Staple length (cm.)	Body type (score)	Condition (score)
Columbia	-.271	-.009	-.009	-.006
Targhee	-.341	.002	-.012	-.009
Corriedale	-.369	.015	-.005	-.011

There was a decrease in merit for body weight, body type score, and condition score as the percent of inbreeding increased. The change of each of these traits with inbreeding was of sufficient importance to warrant correction for wide differences in inbreeding among weanling offspring. There was no important change of staple length with inbreeding.

Rambouillet lambs were heavier at birth than Targhee-Rambouillet crossbreds, while at weaning time the Rambouillet ewe lambs were slightly heavier and the ram lambs a little lighter. Targhee-Rambouillet crossbreds were superior to Rambouillets in length of staple, type and condition scores, and freedom from neck folds. There was little difference in the two groups in face covering.

From selection at weaning time 81 percent of the Columbia-Rambouillet crossbred ewe lambs, 75 percent of the Targhee-Rambouillet crossbreds, and 78 percent of the Rambouillet ewe lambs were saved for breeding.

It appears from the results of the first cross that the mating of Columbia rams to Rambouillet ewes is more desirable than mating Targhee rams to Rambouillet ewes for producing foundation Targhee ewe stock. However, neither cross in this trial produced length of staple or smoothness equal to straight Targhee lambs.

EFFECT OF INBREEDING OF COLUMBIA, TARGHEE, AND CORRIEDALE SHEEP

A study of the effect of inbreeding on weanling traits was made on 474 Columbia, 286 Targhee, and 296 Corriedale lambs born in 1941 and 1942. The changes in each trait with each one percent increase in inbreeding for the various breeds are shown in the following table:

Breed	Average change with each 1% increase of inbreeding in: Body weight (lbs.)	Staple length (cm.)	Body type (score)	Condition (score)
Columbia	-.271	-.016	-.019	-.009
Targhee	-.341	.002	-.012	-.009
Corriedale	-.369	.012	-.005	-.011

There was a decrease in merit for body weight, body type score, and condition score as the percent of inbreeding increased. The change of each of these traits with inbreeding was of sufficient importance to warrant correction for wide differences in inbreeding among weanling offspring. There was no important change of staple length with inbreeding.

INCREASING THE ACCURACY OF SELECTION OF COLUMBIA, TARGHEE AND CORRIEDALE SHEEP

The influence of sex, twinning, age of dam, and age at weaning on weanling traits was studied on 478 Columbia, 366 Targhee, and 238 Corriedale lambs born in 1941 and 1942. Most of the differences were highly significant although not all of them were large enough to be of practical importance.

The differences in the various traits due to the above factors are listed in the following table:

Trait	Advantage of				
	Rams over ewes	Singles over twins raised as twins	Singles over twins raised as singles	Older dams over 2-year-old dams	Ave. change per day at weaning
COLUMBIA					
Body weight (lbs.)	6.1*	13.6*	7.0*	10.0*	.475*
Staple length (cm.)	-.51*	-.11	.31	.37*	.022*
Body type (score)	-.20	.39*	.33*	.30*	.023*
Condition (score)	-.09	.30*	.27*	.28*	.015
TARGHEE					
Body weight (lbs.)	8.1*	9.1*	4.6*	6.6*	.469*
Staple length (cm.)	-.20*	.31	.48	.95*	.019*
Body type (score)	-.26	.32*	.07*	.20*	.017*
Condition (score)	-.06	.21*	.09*	.22*	.014
CORRIEDALE					
Body weight (lbs.)	8.2*	11.1*	2.9*	8.6*	.424*
Staple length (cm.)	-.34*	.03	.19	.30*	-.004
Body type (score)	-.12	.47*	.07*	.24*	.019*
Condition (score)	-.05	.34*	.06*	.31*	.007

The asterisk after the differences indicates that it will be used in correcting weanling data. The amount of change due to each factor was determined independently of the effects of the other factors.

These corrections are used to eliminate known non-genetic causes of variation. For instance, on the average, a twin Columbia lamb from a 2-year-old dam would weigh nearly 24 pounds less at weaning time than

a single lamb from a mature ewe if they were equal genetically and equally affected by other environmental factors.

Correction for sex permits the combining of data from ram and ewe lambs in progeny test results without the confusion due to normal variations in the sex ratio. If uncorrected data are combined, sires which have a majority of ram lambs are given an advantage in body weight over sires which have a majority of daughters.

LAMB PRODUCTION STUDIES WITH COLUMBIA SHEEP

Quantity of lamb produced is probably the most important trait, economically, in range sheep production. Selection of ewes for this trait must be largely based on the relationships of early measures of fertility to later production.

Preliminary estimates of the relation of measures of fertility in the first lambing year to later production have been obtained from data on 214 Columbia ewes which remained in the flock 5 years or more. These data are given in the following table:

First lambing year		No. of ewes	Ave. lbs. lamb weaned per ewe year for 2nd, 3rd, and 4th lambing years
Lambs born	Lambs weaned		
0	0	17	64.9
1	0	59	78.6
1	1	121	81.0
2	0 or 1 or 2	17	84.0

The increasing production in later years with increased levels of fertility in the first year indicates that first years production will be of considerable value in selecting for high production. Plans are now being developed for a much more extensive study of this problem.

SELECTION PRACTICED WITH COLUMBIA, TARGHEE, AND CORRIEDALE WEANLING LAMBS

Advantage of the selected lambs in the following table represents the difference between their average and the average for the entire group after corrections for environmental influences have been made. The percent of ram lambs saved was 77, 50, and 48 for the Columbia, Targhees, and Corriedales respectively. The percent of ewe lambs saved from the 3 breeds was 84, 79, and 81 respectively.

The relative emphasis each trait received in selection was determined by dividing the selection differential by the standard deviation. Thus, the opportunity for selection is also taken into account. Type score received greatest emphasis in all cases except for Corriedale ewe lambs.

Selection Differentials for Columbia, Targhee and Corriedale Weanling Lambs in 1944

			Staple length (cm.)	Weaning weight (lbs.)	Type score	Condition score
Columbia	(Rams	(Advantage of (selected lambs	.10	1.60	.12	.05
		(Relative (emphasis	.13	.14	.27	.10
	(Ewes	(Advantage of (selected lambs	-.02	1.31	.07	.08
		(Relative (emphasis	--	.11	.16	.16
Targhee	(Rams	(Advantage of (selected lambs	.09	2.86	.22	.14
		(Relative (emphasis	.20	.29	.48	.27
	(Ewes	(Advantage of (selected lambs	.08	.56	.09	.03
		(Relative (emphasis	.18	.06	.20	.06
Corriedale	(Rams	(Advantage of (selected lambs	-.12	3.53	.20	.23
		(Relative (emphasis	--	.38	.44	.44
	(Ewes	(Advantage of (selected lambs	.08	.83	.03	-.02
		(Relative (emphasis	.11	.09	.07	--

Summary of Wool Production for 1944 and Four Preceding Years for
Columbia, Targhee and Corriedale Yearling Ewes
(adjusted to 365 days growth)

Years	1944	1943	1942	1941	1940
Fleece Characters	Mean	Mean	Mean	Mean	Mean
COLUMBIA					
Fleece weight (grease) lbs.	9.51	9.06	8.87	10.67	11.39
Fleece weight (clean, bone dry) lbs.	4.06*	3.94*	4.13	4.10	4.22
Commercial for breed	4.61	4.48	4.69	4.66	4.80
Clean yield (bone dry) %	42.69	43.29	46.51	38.46	37.05
Commercial for breed	48.47	49.19	52.85	43.70	42.10
Staple length (cm.)	9.31	9.48	9.53	8.29	8.33
Staple length (inches)	3.67	3.73	3.75	3.26	3.28
TARGHEE					
Fleece weight (grease) lbs.	8.53	7.96	9.39	9.92	9.44
Fleece weight (clean, bone dry) lbs.	3.42*	3.50*	3.81	3.59	3.72
Commercial for breed	3.89	3.98	4.33	4.08	4.23
Clean yield (bone dry) %	40.09	43.10	47.92	38.19	37.53
Commercial for breed	45.60	48.98	54.45	43.40	42.65
Staple length (cm.)	7.86	8.11	8.10	7.50	7.00
Staple length (inches)	3.09	3.19	3.19	2.95	2.75
CORRIEDALE					
Fleece weight (grease) lbs.	8.44	8.54	7.88	9.53	9.38
Fleece weight (clean, bone dry) lbs.	4.16*	3.86*	3.93	4.01	3.81
Commercial for breed	4.73	4.39	4.47	4.56	4.33
Clean yield (bone dry) %	49.29	44.03	49.90	42.07	40.66
Commercial for breed	56.04	50.03	56.70	47.81	46.20
Staple length (cm.)	9.59	9.85	10.10	8.98	8.36
Staple length (inches)	3.78	3.88	3.98	3.54	3.29

*Estimated from nomograph by use of grease fleece weight and staple length.

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